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U. S. DEPARTMENT OF AGRICULTURE

REPORT

OF

THE ENTOMOLOGIST

FOR

1911

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STATE PLANT BOARD

BY

L. O. HOWARD.

[FROM ANNUAL REPORTS OF THE DEPARTMENT OF AGRICULTURE.]



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REPORT OF THE ENTOMOLOGIST.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., August 7, 1911.

SIR: I submit herewith an executive report covering the work of the Bureau of Entomology for the fiscal year ending June 30, 1911, dividing it, in accordance with your instructions, under the following headings:

(1) A summary of the important work carried on during the fiscal year ending June 30, 1911.

(2) An outline of plans proposed for work during the fiscal year ending June 30, 1912, under appropriations already made for that year.

(3) Plans of work recommended for the year ending June 30, 1913.

Respectfully,

L. O. HOWARD,
Entomologist and Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

WORK OF THE YEAR.

The work of the year beginning July 1, 1910, and ending June 30, 1911, may be classified, as was the case last year, as follows:

- (1) Work on the gipsy moth and the brown-tail moth.
- (2) Importations of useful insects.
- (3) Exportations of useful insects.
- (4) Work on insects injurious to southern field crops.
- (5) Investigations of insects damaging forests.
- (6) Investigations of insects damaging deciduous fruit trees.
- (7) Cereal and forage plant insect investigations.
- (8) Work on insects affecting vegetable crops.
- (9) Work on insects affecting citrus fruits.
- (10) Investigations of insects in their direct relation to the health of man and domestic animals.
- (11) Work on insects injurious to stored products.
- (12) Inspection work.
- (13) Work in bee culture.
- (14) Unclassified work.

FIELD WORK AGAINST THE GIPSY MOTH AND THE BROWN-TAIL MOTH.

There has been no important change from previous years in the methods by which the field work against the gipsy moth and the brown-tail moth has been carried on. The area infested by the

gipsy moth has increased but slightly, except in Maine, where it has about doubled. Cooperative work in the several affected States has been continued as formerly. The bureau work has been confined almost exclusively to the gipsy moth. Conditions in general do not seem to be any worse than in preceding years, and in a great many instances are very much improved. From the work that has been carried on under the bureau, together with that done by the State, from the occurrence of the wilt disease, from the increasing importance of the introduced parasites, and from probably favorable weather conditions, the eastern portion of Massachusetts was in better condition than it has been for a long time. Defoliation of the street shade trees in cities and villages has been hardly noticeable, except in a few spots, and the same may be said for the roadside trees over many hundreds of miles of road. In the height of the caterpillar season occasional patches of defoliated forest could be seen, but these were by no means as large or as numerous as in previous years.

The brown-tail moth has become disseminated more widely, having extended its ravages considerably westward and slightly northward, for the reason that the brown-tail moths of both sexes are rapid fliers and general control of the spread is beyond the influence of man.

WORK IN MASSACHUSETTS.

In Massachusetts the work has been largely that of caring for the wooded roadsides along the most traveled highways. Several hundreds of miles have been kept practically clean. Nearly all of this work has been done between the northeast and northwest line from Boston. Several hundred miles of these roadsides which have been taken care of during the past two to four years have been left to the towns, in order that the work of the bureau might be extended to roadsides farther away. A large part of the work of this character in Massachusetts has now been completed. The treatment given to the roadsides has been the removal of the underbrush and the dead limbs from the larger trees, the creosoting of the egg clusters of the gipsy moth, the banding of the trees with sticky bands, and the spraying of the foliage with arsenate of lead.

A force of men has been kept scouting in towns not before known to be infested by the gipsy moth, resulting in the addition of 11 towns to the known infested area of Massachusetts. Practically all of the towns between the known infested area and the Connecticut River, and including a tier of towns west of the river, have been carefully examined, and the heretofore uninhabited towns in the southeastern part of the State have been scouted. In the 11 new towns no large colonies were found.

WORK IN NEW HAMPSHIRE.

Scouting for the egg clusters of the gipsy moth was begun in New Hampshire about October 15, and approximately 100 men were continued in the work until the larvae began to crawl. The winter was favorable for this kind of work, as there was little deep snow, except in the hilly sections west of the Merrimac Valley. In the outer towns covered in this scouting work practically every tree except in the

woodlands has been examined and all egg clusters have been creosoted. In the more seriously infested towns in the southeastern part of the State such thorough work could not be undertaken, and the creosoting was done only along the roadsides, usually to a distance of about 100 feet back from the road. Four towns in New Hampshire have been added to the infested area, there being in all 125 towns in which the gipsy moth has been found. In several of the northern towns no moths were found and it is thought that the pest has been exterminated there. This cleared area about equals the newly infested area. In several other towns there is a marked decrease in the number of egg clusters.

The New Hampshire Legislature made an appropriation during its session of 1911, but the funds do not become available until September 1, so that whatever summer work is accomplished must be done by the bureau. The trees embraced in the territory covered by two tiers of towns on the outer border of the infested area have been burlapped, and about 60 men were employed to attend the bands.

The brown-tail moth situation in New Hampshire is very serious.

WORK IN MAINE.

In Maine the bureau carried a force of men for eight or nine months scouting and creosoting egg clusters. The gipsy moth has been found in 30 additional towns, about doubling the infested area. In only two or three of these towns, however, have well-developed colonies been located. In the great majority of instances single egg clusters were found. Until the winter and spring of 1911 there were not known to be gipsy moths east of Portland, but the scouts have located them continuously for about 40 miles east of that city. The brown-tail moth has not occurred as yet north of the forty-fifth parallel of latitude in Maine.

WORK IN RHODE ISLAND.

A considerable colony was found at North Smithfield, R. I. About 500 egg clusters were creosoted and the locality was given a careful cleaning. It was afterwards gone over by the State moth force, and ought not to become serious if given careful attention by the State.

The brown-tail moth is gaining a strong foothold in the northeastern part of Rhode Island, and is causing people some trouble.

WORK IN CONNECTICUT.

The gipsy moth colony at Stonington, Conn., has not been wholly eradicated, but conditions are not more serious than a year ago. The State took care of the colony during the summer, and in the early winter one of the most experienced scouts in the bureau could find only two or three egg clusters. The gipsy moth colony at Wallingford, upon which the State began operations in December, 1909, is quite well under control. During the winter of 1909-10 several thousand egg clusters were creosoted, and last winter less than 30 were found. The bureau scouts have examined all the towns along the main route of automobile travel from New Haven to the Massachusetts line. No gipsy moths were found.

The brown-tail moth has established itself in the northeastern part of the State in several towns. A line from Providence to Springfield, Mass., would include practically the area infested.

GENERAL CONDITIONS.

The force of men on the pay roll has varied from 170 to 540. As the roadside work is carried from the cities into the farming districts we have been able to get men for the work who are more accustomed to hard outdoor labor, and the efficiency of the force is constantly increasing.

During the feeding season of the caterpillars, 10 gasoline-power spraying machines were used, and approximately 40 tons of arsenate of lead have been distributed.

The inspection of forest products shipped from the infested territory to points around its outer border has been continued, and Christmas trees and wreaths for holiday decoration have been added to the list of material which the transportation companies will not accept without inspection certificates or permits.

A most important series of experiments has been carried on with regard to the relative resistance of native trees to the attack of the gipsy moth. All publications upon the feeding habits of the gipsy moth caterpillar state that the food plants include almost our entire native flora. Although it has long been known that this insect has its favorite food plants, very few trees have been considered as immune or even resistant. It now transpires that a number of species of trees are resistant if in clean stands, or in mixed stands when all the trees are of the varieties considered resistant. An experiment, for example, has been made on a 17-acre tract of chestnut, the owners of which granted permission for the removal of all trees except those thought to be resistant. The tract was badly infested with egg clusters, which were left untreated. The trees have not been sprayed, and only a few along the roadside have been banded. The underbrush was removed, together with all the oaks and birches. There are now no trees standing on the ground except the chestnuts and a few white pines. The result was that the foliage continued practically perfect.

On another experimental tract in the town of Methuen the pines, hemlocks, and maples only were left. The egg masses were not creosoted except on a few trees. The trees on a strip 200 feet wide were banded where this lot adjoins another infested but untreated wood lot. No spraying has been done and no other attention given except to keep the few bands in a perfect condition. The foliage on this tract remained nearly perfect, whereas many of these trees would have suffered severely if the favorite food trees had been left growing, since when the foliage of the latter was consumed the others would have been attacked by the well-grown caterpillars. It seems that the trees most subject to attacks of the gipsy moth, the removal of which is advised wherever possible, are the neglected apple trees, the oaks, the birches, and the willows. The same species are favorite food trees for the caterpillars of the brown-tail moth.

The reason for the success of this new method seems to be that the young caterpillars of the gipsy moth are able to feed only upon the foliage of the favorite plants, and that when the eggs happen to have been placed upon one of the resistant species they are unable to

eat the leaves at first and spin down to the ground, where they feed upon underbrush and scrub oak until they reach a very considerable size. Having reached this size, they climb into the more resistant trees and are at that stage able to eat their leaves. As the result of this season's work it seems entirely possible to keep large bodies of woodland in perfectly good condition and well stocked with trees by the destruction of the underbrush and of the trees preferred by the caterpillars. The woodlot in Methuen, referred to above, contains an admirable stand of timber, and will probably not be harmed by the gipsy moth if some pains are taken to keep down scrub oak and other underbrush.

IMPORTATIONS OF USEFUL INSECTS.

IMPORTATIONS OF INSECT ENEMIES OF THE GIPSY MOTH AND THE BROWN-TAIL MOTH.

The work of introducing the parasites and predatory enemies of the gipsy and brown-tail moths has been continued throughout the year in cooperation with the State of Massachusetts, and during the midsummer a force of 37 men was employed to carry on the work at the laboratory and to make the necessary investigations in the field.

At the close of the fiscal year 1910 it was found that all the species of parasites which could be secured from importations of brown-tail moth hibernating nests had already been liberated and had become established to such an extent as to warrant the discontinuance of further importations of this kind. The results of later work have amply justified this course, and it has been very encouraging to find that all of the parasites which have been introduced in this way have reproduced and dispersed in a very satisfactory manner during the past season.

By means of a careful system of making field collections and checking up the spread of various imported species in the infested area in New England, it has been found possible to determine the present range of many of the introduced species. *Monodontomerus aereus*, which attacks the gipsy and brown-tail moths in the pupal stage, and which was found a year ago in nearly all of the towns between Boston and the New Hampshire line, has dispersed widely and is now to be found over practically the whole of eastern Massachusetts, in several towns near Providence, R. I., through the southern part of New Hampshire, and has extended into eastern Maine to a point nearly halfway between Portland and Bangor. *Pteromalus egregius*, a species which destroys brown-tail caterpillars in the winter webs, has been found in small numbers over a widely scattered area in Massachusetts, New Hampshire, and Maine. Two of the most promising parasites that attack brown-tail moths, namely, *Apanteles lacteicolor* and *Meteorus versicolor*, have greatly increased their range during the past year. The former has been found over approximately four times as much territory as that occupied a year ago, and while the latter has not been secured from as many additional towns, the increase is satisfactory, owing to the extreme difficulty of recovering the species in the field unless it occurs in considerable abundance.

One of the tachinid flies, *Zygobothria nidicola*, mentioned in the previous report, which destroys brown-tail caterpillars when they

are nearly full grown, has been recovered in encouraging numbers this year, and another tachinid, *Parexorista cheloniae*, has also been secured in small numbers.

The increase of the various parasites that attack the brown-tail moth, therefore, has been most satisfactory. It may be necessary, however, to import still other enemies which will make more perfect the sequence of parasites necessary to bring about entire control.

Excellent results in this direction have been accomplished by the importation and colonization this year of a strong colony of *Eudoromyia magnicornis*. This insect has never been secured in sufficient numbers previously to give it a proper chance to develop, but as over 7,000 specimens have been liberated this year as a result of the importations of large brown-tail caterpillars from Russia, Spain, and Italy, it is possible to give this species an excellent opportunity to become established. It should be noted that the species above mentioned are not only spreading satisfactorily, and in some cases more than we dared hope, but that the returns from collections taken from selected portions of the infested territory indicate that most of them are increasing in the territory where they were found last year.

This has been particularly true of the tachinid fly *Compsilura concinnata*, which attacks gipsy and brown-tail caterpillars as well as many native ones. The species has become abundant enough in the central portion of the infested district so that specimens have been found by property owners without especial search and have been sent to the laboratory for identification. This species is now spread throughout the generally infested area of Massachusetts, and has been received from several towns over the New Hampshire line.

The increase and spread of the imported *Calosoma* beetle were pointed out in the last report. Returns thus far secured during the present year show a continued increase in the spread of this species, and in the badly infested section where this beetle has been found abundantly during the present season enormous inroads have been made on the gipsy moth caterpillars and pupæ, and in some cases it has been difficult to collect pupæ even in areas that were quite badly infested in the early summer, this result being due entirely to the good work done by this beetle. It is not expected that this insect will ever be able to control the situation, although it is plainly evident that it will eventually become a powerful force in helping to hold the gipsy moth in check.

One of the egg parasites of the gipsy moth, *Schedius kuvanæ*, which is expected to become a most useful ally and which has great possibilities owing to the fact that several generations develop in a single year, has fortunately shown positive results in the field, and it is probable that the species will withstand the severe New England winters. Another egg parasite, *Anastatus bifasciatus*, is reproducing satisfactorily under natural outdoor conditions. Its spread is slow, and it does not develop in large numbers rapidly, since it has only one generation a year, but it will in time become a useful parasite.

Aside from stopping the importation of brown-tail moth nests in large numbers, there has been no effort the present year to import large quantities of parasitized caterpillars from the localities from which good colonies have already been secured. There have been,

however, large importations from Spain and from Russia. An especial effort has been made to introduce parasites not yet received in this country in sufficient numbers to establish themselves. Mr. W. F. Fiske, in charge of the laboratory, was stationed in January in southern Italy, and remained there until the close of the fiscal year, Mr. A. F. Burgess being left in charge of the laboratory. Mr. Fiske's efforts have been very successful, and he has sent over in large numbers four species parasitic upon gipsy moth caterpillars and another species which attacks gipsy moth pupæ, and these in most cases have come in excellent condition, owing to the superior manner in which they were packed and shipped. One of these species, *Apanteles solitarius*, has been liberated to the number of 23,000 adults. While it is difficult to secure evidence that this species has reproduced, owing to the fact that the cocoons are attached singly to caterpillars which are often on the leaves high in the trees, it has been possible to determine by actual rearing from material collected in the field that some of them have passed through a single generation on American soil. The parasite of the pupæ, *Chalcis flavipes*, has been liberated to the number of 10,000. This species had never before been received in sufficient numbers to make a satisfactory colonization. Another important parasite, previously received in small numbers from Russia and which was not known to occur in Italy, was found by Mr. Fiske in Sicily, and over 125,000 of its living cocoons were sent to Massachusetts in good condition.

Aside from the work of importing colonies, reproduction work, and checking up the results of the liberations that are made, it has been possible to carry on numerous minor investigations to determine the relation between the parasites imported and our native species, as well as to study the rôle which the former are likely to play in connection with various native caterpillars upon which some of them must depend to pass through a generation after the gipsy and brown-tail moths have completed their single generation. This work has necessitated the construction of new equipment and the development of more perfect rearing devices.

ATTEMPTED IMPORTATION OF THE INSECT ENEMIES OF THE WHITE FLY.

In July, 1910, an expert field agent of the bureau was sent abroad to find the original home of the white fly of the orange and to attempt to find the parasites or satisfactory predatory enemies. In November, 1910, he found the white fly at Saharampur, India, under conditions that seemed to indicate that the white fly is indigenous to that part of the country. He found that it was attacked by two species of ladybird beetles. A preliminary shipment of these beetles by mail was apparently unsuccessful. Later shipments by direct steamer from Calcutta to Boston were also unsuccessful. At Lahore, India, he found his first evidence of parasitism by internal parasites. A certain proportion of the white flies was found to contain exit holes of a true parasite. Upon the leaves sent in were found 5 specimens of a very minute parasite, which has been described as *Prospaltella lahorensis*. After visiting Java and Manila, the agent, Mr. R. S. Woglum, returned to India, and at the close of the fiscal year was engaged in an attempt to rear the parasites in sufficient numbers for introduction into the United States before the close of the summer.

IMPORTATIONS OF PARASITES OF THE ALFALFA WEEVIL.

The difficulty of fighting the recently imported alfalfa weevil in the alfalfa fields of Utah by mechanical and cultural means has started an investigation as to its parasites in its original home. Mr. Fiske, of the bureau, located at Naples, sent, in March and April, large lots of the stems of alfalfa containing eggs of an allied weevil parasitized by a minute parasite, all of which arrived in good condition in Salt Lake City, the parasites emerging in numbers, and an attempt is now being made by agents of the bureau to establish them in the Utah fields. Three other species were sent later.

IMPORTATIONS OF PARASITES OF THE IMPORTED ELM LEAF-BEETLE.

The agent at Naples succeeded in sending over in good condition eggs of the imported elm leaf-beetle, parasitized by a minute chalcidid—the same species imported three years ago, which has not been rediscovered in the open in this country. He also sent over a dipterous parasite of the same insect, which also arrived in good condition. Attempts are being made to establish both of these species.

EXPORTATIONS OF USEFUL INSECTS.

An assistant in the bureau receiving a temporary appointment as entomologist to the department of agriculture of Peru, especially to study the injurious work of a scale insect on cotton, has been sent during the year a number of shipments of a minute parasite of a closely allied species from Washington. It is too early to announce results.

In the summer of 1910 Dr. L. P. de Bussy, biologist of the Tobacco Planters' Association at Deli, Sumatra, visited the United States for the purpose of investigating the damage to the tobacco crop by insects and disease and to make an effort to import into Sumatra the parasites of a destructive tobacco worm. Shipments of an egg parasite of this insect have been started by agents of the bureau in Texas and have gone to Sumatra via Amsterdam, but information as to the results of these preliminary shipments has not yet reached this country.

The brown-tail moth having entered the Province of New Brunswick, an agent of the Central Experimental Farm of the Dominion of Canada has been sent there, and to him has been shipped a colony of a dipterous parasite which has been established in Massachusetts and which occurs there in very considerable abundance.

It is considered most advisable to continue this attempt to assist foreign Governments in this way wherever possible, since by this course a most perfect understanding has been brought about among the workers in these lines in the different countries, and the United States has profited greatly by return courtesies of the same general character. The official economic entomologists of all of the Governments of the world form practically a coherent body, with almost identical interests and with every incentive for mutual assistance.

WORK ON INSECTS AFFECTING SOUTHERN FIELD CROPS.

The work on insects affecting southern field crops consisted of the investigation of eight groups of problems, as follows: (1) The cot-

ton boll weevil, (2) tobacco insects, (3) sugar-cane insects, (4) rice insects, (5) the Argentine ant, (6) the cotton red spider, (7) cactus insects, (8) ticks.

The work was conducted under the direction of Mr. W. D. Hunter, whose headquarters were at Dallas Tex., and branch stations were located at Sabinal, Tex.; Crowley, La.; New Orleans, La.; Tallulah, La.; Clarksville, Tenn.; Appomattox, Va.; and Batesburg, S. C.

THE COTTON BOLL WEEVIL.

During the year the cotton boll weevil extended its range into the State of Alabama. The season as a whole, however, was again very abnormal as regards weevil damage. On account of the peculiar conditions of the preceding summer and winter, as pointed out in the last report, a very small number of weevils issued from hibernation in the spring of 1910, and unprecedented drought from the start prevented the normal increase in the number of weevils in the field. In August so great was the effect of these checks that the weevil had done no noticeable damage to the crop in Oklahoma, and the same is true for a large area in northern and western Texas. Central Louisiana, southwestern Mississippi, and the river bottoms of the coastal region of Texas suffered more seriously than any other part of the infested region. There was a smaller increase in infested territory during the year than in any year since 1903.

The most important line of work undertaken at the Delta laboratory at Tallulah, La., was the testing of the possibility of the use of powdered arsenate of lead or other poisons in the control of the weevil. This work was suggested by the apparently favorable outcome of earlier experiments by the Louisiana Crop Pest Commission. The results of the year's experiments were largely contradictory and inconclusive. The abnormal conditions of the season and the unusually small number of weevils present were partly the cause of this. Apparently successful results were obtained in certain plats, while others on the same plantation failed to show any profit from the use of poison.

It has been found that in many quarters there are serious objections to the burning of the cotton plants in the fall. In regions where cotton has been cultivated for many years and the soil has been robbed of its humus, this objection is especially strong. The one best remedy for the weevil is the destruction of the plants in the autumn, and burning has been recommended by the bureau, but some plan less open to objection from a broad agricultural standpoint must be devised. Therefore every form or method of the burial of plants which could be practiced upon the plantation has been tried and compared against the burning of the plants at the same time. If the plants could be killed while standing in the autumn, an important advance would be gained, since it would prevent the production of the fall broods of the weevil, which are the ones which pass through the winter in the greatest numbers. An important difficulty in the method of fall destruction now practiced is that the labor available is frequently insufficient to pick the crop by the time the plants should be uprooted, whereas if a method of killing the plants while they are still standing could be devised it would be possible to continue picking the staple all through the winter. Tests have been made of various chemical means of killing the plants with this end

in view. There are many important practical obstacles to be overcome, but the work done has yielded results sufficiently definite to warrant hope of a successful outcome.

The study of the parasites of the boll weevil was continued, and experiments were made in introducing Texas parasites at two points in Louisiana, namely, Crowley and Livonia.

The study of the local modifications in the habits and life history of the weevil under the conditions of the Mississippi Delta was continued; a large number of remedies was tested, and in addition to poisons and repellents of various sorts a number of special machines was investigated. The importance of trying every remedy suggested, in order that definite advice may be given to planters, was indicated during the season by the organization of a large company in Texas for the sale of cotton seed treated by some chemical process which was claimed to have the effect of making the plants immune to weevil attack.

During the season the exact status of the boll weevil throughout the infested territory was determined. This work is necessary in order that the bureau may be ready to furnish information demanded by planters, cotton dealers, and others, and is of especial importance to States that are about to be invaded by the weevil.

The advance of the boll weevil into new regions was investigated with care. In this work the bureau cooperated with the entomologists of several States, notably Mississippi and Alabama.

TOBACCO INSECT INVESTIGATIONS.

The principal work on tobacco insects consisted of (1) investigations of means of control of the so-called hornworms and (2) the investigation of the control of the so-called tobacco wireworm (*Crambus caliginosellus*). The headquarters for the work on hornworms were at Clarksville, Tenn.; those for the wireworm investigations at Appomattox, Va.

The main work on the hornworms was the investigation of control by either chemical or cultural methods. With chemical methods many experiments were tried with arsenate of iron, arsenate of lead, Paris green, and arsenic bisulphid. The latter substance was very effective when applied at the rate of 2 pounds per acre—about as effective as Paris green. It can be applied without the use of a carrier and its bulk per pound is less than that of Paris green. The price should be very low. This substance, however, has a caustic effect upon the tobacco plant, but since the product used in the experimental work was not especially prepared for an insecticide, strong hopes are entertained that the especially washed product on hand for use during the present year may prove to be harmless to the tobacco. Some interesting points were ascertained regarding cultural methods of control of the hornworms, but the chemical means of reducing injury will best suit the needs of the planters.

The work on the tobacco wireworm has progressed in a satisfactory manner. The previous season's studies on the life history and seasonal history were verified and enlarged. Many experiments with remedies were conducted. All observations and experiments strengthened the belief that it is only by cultural means that this pest can be controlled. It feeds naturally upon certain weeds, and these weeds

are eliminated by certain rotations of crops. In this way tobacco or corn, which is also attacked by the same insect, has been freed from injury. Thus a practical system of avoiding serious damage has been perfected.

Other tobacco insects have received incidental attention.

SUGAR-CANE INSECT INVESTIGATIONS.

The work on sugar-cane insects was interrupted temporarily by the resignation of the agent in charge, who left the service August 31, 1910, but has been continued in a satisfactory manner by his successor. The investigations have dealt with the means of control of the sugar-cane borer, the sugar-cane beetle, and the mealy bug, and have also included special study of the treatment of seed cane to prevent the infestation of new localities by serious pests. All of this work has been done in cooperation with the Louisiana Sugar Experiment Station.

As the sugar-cane borer is by far the most important enemy of the crop in this country, the work was largely concentrated on this species. Extended investigation was made during the fall of 1910 of the different classes of injury which this insect inflicts upon sugar cane, and the results have been published. Observations were also made and a considerable amount of valuable information was gained regarding the hibernation and spring emergence of the cane borer, the results of thorough cleaning up of the cane fields in the fall, and other methods of control. An interesting experiment was carried on to test the effect of surrounding sugar cane with different crops. The crops being used at present are corn and cowpeas. This experiment will require two years for completion, and will include results with stubble, fall plant cane, and spring plant cane. During the year it was announced by a member of the bureau force that the larger corn stalk-borer of the Eastern States is a distinct species from the sugar-cane borer in the South. If this distinction holds good in Louisiana, it will entirely upset all recommendations regarding the planting of corn upon cane plantations. The experiments so far carried on, however, indicate that the forms in cane and corn in Louisiana are identical. An investigation of the egg parasites of the cane borer was also begun.

The sugar-cane mealy bug appears to be restricted to certain localities in Louisiana, but threatens to become generally distributed. A predatory beetle was brought from California in large numbers, which fed for two generations upon mealy bugs, apparently with great success, but later died out.

The experiments with seed cane included fumigation with hydrocyanic-acid gas, lime-sulphur dip, and whale-oil soap dip, together with other treatments. The three just mentioned gave the best preliminary results.

RICE INSECT INVESTIGATIONS.

At the beginning of the fiscal year an agent was stationed at Crowley, La., to begin studies and experiments in the control of the more important enemies of rice. The Louisiana Rice Experiment Station cooperated generously by furnishing laboratory facilities and access to a large number of experimental rice plats. The work was devoted principally to the rice weevil, which is the most important enemy of

rice in Louisiana and Texas. The primary work was to investigate the life history of this insect, concerning which very little is known. At the same time plans were made for testing remedial measures. Among the most promising of these are certain changes in manipulation of the water used for irrigation. As the insect is of an aquatic nature, it seems probable that deferred flooding of the field or the withdrawal of water for a short time during the growing season may result in considerable relief. Experiments with a number of modifications of the system of managing water were instituted at Crowley, in cooperation with the Louisiana Rice Experiment Station, and also at Stuttgart, Ark., in cooperation with the Division of Irrigation Investigations of the Office of Experiment Stations.

ARGENTINE ANT INVESTIGATIONS.

The work on the Argentine ant problem was continued. Life-history investigations were carried on, and experiments were made to discover effective means of control. Several fresh centers of infestation were discovered, so that the area affected is much larger than had been supposed. Remedial work was restricted largely to experiments in orange orchards in Louisiana. Here the ant has threatened to destroy a very profitable industry. It was found during the preceding year that large numbers of the ants could be attracted to shelter provided in boxes placed at convenient points throughout the groves. In many cases all of the ants in the field appeared to make their way into these shelters, and the experimental work in the way of destroying them in these shelters indicates that a very efficient means of control has been discovered for this insect under orchard conditions; but the method is not well adapted to city surroundings, where the ants find winter quarters under houses almost as attractive as the trap boxes. Hydrocyanic-acid gas was found not to have sufficient penetrating power to work with the traps, but bisulphid of carbon ultimately proved to be very effective and penetrated to the most remote corners of the trap boxes.

COTTON RED SPIDER INVESTIGATIONS.

Prior to 1910 some observations on the cotton red spider had been made by occasional trips of agents of the bureau to Batesburg, S. C., and other points in that State. During 1910 an agent was detailed for continuous work on this problem. He was stationed at Batesburg early in the season, and remained there until September 1. His work appears to have resulted in two important discoveries, both of which, however, are subject to verification from further studies. One of the discoveries is that the red spider does not pass the winter in the cotton fields, but spreads into the fields from a small number of wild or cultivated plants which remain green during the winter and afford it an opportunity for early breeding in the spring. The second discovery is that a modification of the well-known lime-sulphur mixture, if applied with sufficient thoroughness, will destroy the red spider in all stages.

Experiments in cultural methods of controlling this pest were conducted. Unfortunately, however, it appears doubtful at the present time whether such methods will furnish means satisfactory to the planters.

CACTUS INSECT INVESTIGATIONS.

The work in cactus insect investigations was completed during the year, and the results are about to appear in a bulletin of the bureau.

INVESTIGATIONS OF INSECTS DAMAGING FORESTS.

The work of the bureau on forest insects carried on during the year under the direct supervision of Dr. A. D. Hopkins has related especially to practical demonstrations and direct instructions and advice in the field on the results of investigations which have been carried on in past years. It is fortunate that the work has arrived at the stage where confident directions can be given so that large-scale practical demonstrations can be made with the certainty of beneficial results. The principal work has been carried on from a field station located at Columbia Falls, Mont., and at one located at Baker, Oreg. Investigations have also been carried on by experts in the District of Columbia, Virginia, Maryland, Pennsylvania, New York, Alabama, Georgia, South Carolina, North Carolina, Oregon, California, and Montana. Information has been disseminated to forest owners in nearly all of the States and Territories, and to the Federal officials of this department and the Interior Department, relating to damage to timber on National Forests, national parks, Indian reservations, and the public domains. The progress of the work generally has been very satisfactory.

The principal depredations of the year have been by the *Dendroctonus* beetles on the pines, spruce, and Douglas fir of the Northwest and Pacific Coast States and on the pine of the Southern States. As knowledge increases of the actual losses of merchantable timber caused principally by these beetles, it appears that former estimates have been conservative and that these beetles are in fact one of the principal factors in causing the enormous continued waste of the most valuable timber resources of the Rocky Mountains, the Pacific coast, and the Southern States. During the summer and fall of 1910 and the spring of 1911 there has been a very alarming outbreak of the southern pine beetle in the South Atlantic and Gulf States, and it is evident that unless concerted action is taken by the owners of pine in these States during the coming fall and winter a large percentage of the pine will be dead within the next two years.

It is significant of the practical nature of the methods of control recommended by the bureau and of the practical demonstrations that have been carried on that no complaints of depredations have come to the bureau during the year from the areas in Colorado and Montana where control work was carried on in previous years according to the instructions of the bureau. The same may be said for seasoned forest products which are damaged by the powder-post beetles; very few complaints have been made during the year by manufacturers and dealers who have heretofore suffered extensive losses from this source.

DEMONSTRATION WORK AND RESULTS.

The results of the demonstration work carried on last year in co-operation with private owners in the vicinity of Columbia Falls, Mont., in which over 10,000 trees were treated, are most gratifying,

since, instead of the former annual death of more than 10,000 trees within the area, there were this year only 2,000 requiring treatment within an area of more than 100 square miles. This is undoubtedly the direct result of the control work, which costs nothing, because the treated trees, when utilized for fuel and lumber, are worth far more than the cost of treatment.

Under an arrangement with the Interior Department by which that department allotted \$700 for insect-control work on the Glacier National Park under the immediate instructions of an expert from this bureau, 1,295 trees in the vicinity of McDonald Lake were treated during the year, and present conditions indicate that the work has been successful in arresting the spread of the damage.

Investigations by an expert in the Black Hills during the summer of 1910 show that an end has come to the extensive depredations which have been continuous during the past 10 years and which have resulted in the death of at least 60 per cent of the merchantable timber of the area. These depredations were already diminishing in 1907, so that the treatment of probably not more than 10 per cent of the merchantable sized trees infested in 1907 and 40 per cent of those infested in 1908, in connection with the natural increase of factors detrimental to the beetles, was sufficient to end the trouble.

The most extensive control work that has been attempted in this country was undertaken in northeastern Oregon in the fall of 1910 and completed on June 30, 1911. The work was done in cooperation with the Forest Service, private owners, and the General Land Office of the Department of the Interior, under an arrangement by which the Federal and private owners of the timber furnished the money necessary for carrying on the control work under the immediate supervision of experts from this bureau.

The preliminary reports indicate that 27,158 trees were treated at a cost of \$33,180 to the Forest Service, and that 6,853 trees were treated at a cost of \$2,806 to private owners; the total of 34,011 trees at a total cost of \$35,986. More than 100 men were engaged in the work during May and June. The results of this large control demonstration can not be known until the close of the fiscal year 1912, but it is believed that they will prove to be successful and that the demonstration of methods and training of men for control work will be of the very greatest value in the future.

A review of the control work carried on in the Rocky Mountain region under instructions from this bureau or according to its recommendations shows that since the forest-insect service was established in July, 1902, over 155,400 trees have been treated at an ultimate cost of \$31,211; 114,607 trees having been utilized, so as to more than cover the cost of treatment, while 44,519 trees were treated at a direct expense of \$30,925.

It is estimated that the timber saved as the direct result of control work represents a stumpage value of over \$2,000,000.

INSECT DAMAGE TO TELEPHONE AND TELEGRAPH POLES.

During the past year it has been determined through special investigations conducted by the bureau in cooperation with telephone and telegraph companies that serious and extensive damage is being done in certain localities to standing poles by wood-boring insects. The

principal injury consists in large mines in the wood near the line of contact with the ground, necessitating the frequent resetting and even replacement of the damaged poles. The character and habits of these insects have been studied during the year, and one of them has been shown to have damaged seriously from 10 to 15 per cent of the chestnut poles which have been set in the ground for from 10 to 12 years in lines in North Carolina, Virginia, West Virginia, Maryland, and the District of Columbia. The same insect has also seriously damaged a considerable proportion of the arborvitae telephone poles in part of a line in Illinois. It has been found that by impregnating the poles with creosote, either by the open-tank process or by the cylinder-pressure process, the poles can be effectively protected. The same line of investigation has been extended from the telegraph and telephone poles to mine props and crossties.

INVESTIGATIONS OF INSECTS DAMAGING DECIDUOUS FRUIT TREES.

The investigations of insects damaging deciduous fruit trees have been carried on as before under the direct supervision of Mr. A. L. Quaintance. Several of last year's projects have been continued, and with the spring of 1907 certain additional investigations were entered upon.

THE PEAR THIRPS.

Further details in the life and habits of the pear thrips, a serious enemy of deciduous fruit in California, have been investigated, especial attention having been given to determining the variations in time of appearance of the adults on the trees in the spring due to climatic conditions. Weather conditions obtaining during the spring of 1911 considerably modified the behavior of the insects, and they emerged from the ground over a considerably longer period than usual and were much less abundant at a given time than during former years. For this reason spraying operations against the adults were not as effectual as heretofore, and spraying against the larvæ, later appearing, was of correspondingly greater importance.

The spraying experiments under way in orchards during 1910 were quite successful, as shown by the condition of crops on sprayed and unsprayed plats at picking time of the fruit in the fall. Thus, in the case of prunes in the Santa Clara Valley, the yield from a sprayed block was 367.93 boxes per acre, with a value of \$320.82, as compared with a yield of 7 boxes per acre on the unsprayed block, with a value of \$6.65. On a block of trees thoroughly plowed and cross-plowed in the fall for the destruction of pupæ in the ground the yield was 85.65 boxes per acre, with a value of \$74.85.

In another orchard the yield from 300 trees, which had been thoroughly plowed the fall previously and given three spray applications in the spring, was 136.08 boxes per acre, with a value of \$190.08, while on an adjacent block of 98 trees, which received thorough cultivation in the fall, but no spray applications in the spring, the yield per acre was 26.46 boxes per acre, with a value of \$34.02. From the check block, which received no cultivation or spraying, the yield was but 2 boxes of fruit per acre, with a value of \$2.59.

In addition to the benefits in increasing the yield by plowing and spraying operations, in the case of prunes the treatment greatly increases the value of the crop by preventing scabbiness of fruit, which greatly reduces its market value.

The operations in Contra Costa County were likewise notably successful. Thus, in the case of Bartlett pears, 550 trees which received two spray applications against the adults and a portion of the trees receiving a third application against the larvæ, all trees without exception came into full bloom, while the untreated adjacent trees showed only a few scattered blossoms, and these were badly injured. The yield of No. 1 fruit from the 550 sprayed trees was 1,700 boxes and of No. 2 fruit 150 boxes, with a total value for the entire crop of \$1,435, or about \$2.60 per tree. The unsprayed trees gave a yield of less than one-fourth box per tree, the fruit being much scarred, misshapen, and unmerchantable, and worth not over $12\frac{1}{2}$ cents per tree, thus showing a net benefit from spraying of \$2.125 per tree, or approximately \$225 per acre.

Spraying cherries in Sacramento County also gave satisfactory results. Thus, the net value of fruit per tree in the sprayed blocks was \$8.99, as compared with the valuation of fruit from unsprayed trees of \$0.789 per tree. Deducting the cost of spraying, there is shown a net gain per tree of \$7.49 for spraying, or approximately \$889.80 per acre.

Results of experiments and life-history studies of the thrips were published in Circular 131 of the Bureau of Entomology, issued in January, 1911, which was widely distributed to fruit growers in the infested territory. This publication resulted in a notably increased interest on the part of orchardists in the warfare against this pest. A large number of fruit growers in the Santa Clara Valley and elsewhere provided themselves with power and other spraying apparatus, and a large amount of spraying was accomplished.

In the bureau's field work in the spring of 1911 several orchards were selected for settling additional points which had come up and particularly for carrying out large-scale demonstration spraying.

Agents of the bureau have endeavored to keep in close touch with orchardists, giving them instructions in the preparation and use of sprays, and it is believed that the growers for the most part are now fairly familiar with the rather exacting conditions for successful thrips spraying.

The territory infested by the pear thrips from all available information has apparently not materially increased during the past year. Increased injuries, however, in the Courtland district have been the subject of considerable complaint by growers there located, and it is planned to locate a man in that district during the spraying period another spring.

THE CODLING MOTH.

Work on the codling moth, an important apple pest, has been continued largely along the lines followed during previous years. The detailed life-history studies of the insect, in progress in different fruit regions, are being satisfactorily accomplished, and it will be possible, it is thought, to conclude these observations in the Michigan fruit belt at the close of the present growing season. The studies in Santa Clara Valley, Cal., are also nearing completion. The life-

history investigations alluded to in my last report as in progress in northwestern Pennsylvania have been completed and the results reported upon in Bulletin 80, Part VI. Additional studies of this character will be undertaken another season, if practicable, in the Southwest, perhaps in Arizona or New Mexico, and in the Southeast, possibly in northern Georgia. It is also hoped to make arrangements for similar work in some of the important fruit districts in the arid valleys of the West, where conditions are such that the pest is especially troublesome.

The experiments in progress during 1910 to test the relative merits of the one-spray versus the usual schedule of applications in the control of the codling moth did not, on account of the comparatively little injury in the orchards treated, furnish marked results, so that this work was continued, beginning with the spring of 1911. The experiments are in progress in Kansas, Delaware, West Virginia, and Michigan, and it is hoped that the results of this season's work will permit of final conclusions on the subject.

In conjunction with the one-spray work, demonstrations in spraying are in progress in the localities mentioned, designed especially for the benefit of orchardists. Careful records are being kept of the costs and benefits of the work, so that results may be stated in terms of dollars and cents. The field work also includes the use of several different arsenicals that further information may be obtained regarding their comparative value.

The growing importance of the apple-growing industry throughout the Appalachian Mountain region, especially in the Virginias, North Carolina, and Maryland, has rendered desirable more accurate information relative to the variations in the life and habits of the codling moth due to location, especially as bearing on the times when spraying applications should be made to secure the maximum benefit. A thoroughgoing study of the insect throughout this region was therefore undertaken, beginning with the spring of 1911, and the work assigned to two men, with headquarters in West Virginia. Careful records are being obtained in orchards in both valley and mountain regions, and in the latter case from some localities representing considerable altitudes.

The life-history studies of the codling moth in the Ignacio Valley in California, and the spraying experiments in progress on pears, mentioned in the last report, were completed, and the work reported upon in Bulletin 97, Part II. The results obtained show that it is entirely practicable largely to prevent loss of pears from this insect by timely spraying, and recommendations of the bureau have already been largely adopted by pear growers.

THE PLUM CURCULIO.

The spraying demonstration and experimental work for the plum curculio in the South in progress during 1910, in cooperation with the Bureau of Plant Industry, was successfully completed and the results given in Farmers' Bulletin 440, issued in March, 1911. The results obtained were quite as favorable as those secured during the previous year, and show conclusively the entire practicability of controlling the plum curculio and certain important peach diseases by the use of a combined spray of arsenate of lead and self-boiled

lime-sulphur wash. As a result of the department's work on peach spraying for these troubles, the practice is now followed by a very large number of peach growers. A total of probably 4,500,000 to 5,000,000 trees was sprayed with this mixture during 1910.

Beginning with the spring of 1911 the demonstration work was continued, but located in certain Middle Atlantic and Northern States, as representing distinctly different climatic conditions. Work is in progress in Delaware, West Virginia, and Michigan; and, in addition to work on the peach, plums and cherries are also being treated. In connection with the one-spray and demonstration spraying of the apple against the codling moth, results are also being obtained as to the effect of these treatments on the plum curculio.

A thoroughgoing life-history investigation of the curculio was begun in 1905 in conjunction with other work at several of the bureau's field laboratories and in the insectary in Washington. A large amount of information has now been accumulated on the growth and development of the insect in widely separated localities, as in western New York, in Michigan, in the environs of Washington, D. C., in Georgia, and in Arkansas. These studies sufficiently cover its range of distribution and indicate important variations in its habits and behavior. A full report embodying the results of these investigations has been prepared and submitted for publication.

MISCELLANEOUS APPLE INSECT INVESTIGATIONS.

For some time it has been desired to begin a study of certain important apple pests which, though of less economic importance than the codling moth and San José scale, are nevertheless very troublesome, and each year cost apple growers a large amount in loss of trees, labor, etc.

APPLE-TREE BORERS.—Principally two species of coleopterous borers infest the apple. An investigation of the life and habits of these insects was begun in the spring of 1911, and attention will be given to determining, if possible, economic methods for the protection of trees from their ravages.

WOOLLY APPLE APHIS.—An investigation of this serious pest has also been started and will include an inquiry into its life and habits and the use of remedies for preventing or lessening injuries in orchards and nurseries.

THE FRUIT-TREE LEAF-ROLLER.—Much complaint of ravages by this insect (*Archips argyrosipa*) is received every year from the Southwest, notably New Mexico and central Kansas. In connection with other work in the Southwest, a life-history study of this leaf-roller is in progress, and experimental work for its control is being carried out in New Mexico.

MISCELLANEOUS GRAPE INSECTS.

Several important insect enemies of the grape were given attention during the season of 1910, the work being located at North East, Pa. These were the rose-chafer, the grape leafhopper, and the grape berry moth.

The rose-chafer has continued quite troublesome in vineyards, especially in regions where sandy soils predominate. Investigations of this insect are being continued the present season, and further data

will be obtained on its life history. Especial attention, however, is being given to determining remedies for its control in vineyards, and to protect other crops that are subject to attack. The results of last season's work were very encouraging, and the demand for information on the subject by vineyardists rendered it desirable to furnish a preliminary report, which was issued as Bulletin 97, Part III.

The grape leafhopper, always present in vineyards, periodically becomes abnormally abundant and destructive. This insect is now much in evidence in vineyards in western New York and the Erie Valley, and its injuries have been so severe as to require attention. The work carried out during 1910 indicated that much benefit would result by the timely use of strong nicotine sprays, and further experiments are in progress with this and other washes during the season of 1911. A preliminary report embodying the results of 1910 has been published as Bulletin 97, Part I.

The grape berry moth, alluded to in former reports, is of irregular occurrence in vineyards, though often very destructive. It has thus been difficult to obtain suitably infested vineyards for proper experimentation, though much information has been obtained on the life history of the pest. In order to obtain final data on the use of certain sprays against this insect a badly infested vineyard in the neighborhood of Sandusky, Ohio, is being used the present season for experimental work. In addition to the use of arsenicals, test is being made of the possible value of nicotine sprays, which have recently come into much use against nearly related insects in France.

GRAPE PHYLLOXERA INVESTIGATIONS.

A detailed life-history investigation of the grape phylloxera, a serious grape pest, was begun in the spring of 1911, with headquarters at Walnut Creek, Cal. The study will include its complete life cycle and methods and rate of reproduction, and especial attention will be given to its means of dispersal under California conditions. Information is also being collected on the history, present distribution, destructiveness, and spread of the insect in that State. In cooperation with the Bureau of Plant Industry, experiments are in progress to determine the degree of resistance to the insect of roots of different varieties of grapes. The plants are given colonies of the insect by grafting into the roots pieces of infested roots, and the degree of resistance will be learned by noting the behavior and multiplication of the insects themselves, in addition to the condition of the vines, with which phase of the subject the Bureau of Plant Industry is concerned.

PARASITIC AND PREDACEOUS INSECTS.

As indicated in the report for 1910, it was planned to establish a laboratory for the detailed study and rearing of parasitic and predatory insect enemies of various deciduous-fruit insects. This laboratory has been established and work has been begun. Especial attention is being given to the study of the life histories of certain hymenopterous parasites of the codling moth and plum curculio and also to the study of life histories of certain coccinellid beetles predatory on plant-lice and scale insects. It is hoped that these studies

will result in information which will permit of the propagation in numbers of these beneficial forms and which will also contribute to their more ready establishment in orchards.

INSECTICIDE INVESTIGATIONS.

Laboratory and field experiments have been continued with various insecticides, especially lime and sulphur preparations, several arsenicals and other toxic substances as possible substitutes for these, nicotine sprays, distillate emulsions, etc.

It has appeared that recommendations as to the amount in proportion to water of a given arsenical, as arsenate of lead, which should be used in sprays in the control of certain important pests, are more or less arbitrary and not based on sufficient experimental work. On account of the present large annual use of arsenical sprays, it is very important to know the minimum amount of arsenic required to control a given insect satisfactorily, thus avoiding the waste resulting from the use of an unnecessarily large amount. Some experiments have therefore been undertaken to determine as exactly as possible the quantity of arsenate of lead which should be employed satisfactorily to control the codling moth and plum curculio on apples and peaches. The experiments cover the use of arsenate of lead at strengths ranging from one-half pound to 5 or 6 pounds per 50 gallons of water.

CEREAL AND FORAGE PLANT INSECT INVESTIGATIONS.

The cereal and forage plant insect investigations, carried on under the immediate direction of Mr. F. M. Webster, have shown good results and have opened up several new problems of importance.

WORK ON THE SO-CALLED GREEN BUG.

A threatened outbreak of the so-called green bug demanded attention from a number of members of the force. The manuscript for a bulletin on this pest has been completed and now awaits publication. In future it will be necessary to keep the whole southwestern country under continued surveillance in the fall in order to be able to warn farmers of impending danger from this pest.

WORK ON THE JOINTWORM.

Work on the jointworm has been continued. The damage caused by the insect was less in Ohio and Indiana than during the two previous years, probably due to the attacks upon it of the predaceous mite *Pediculoides ventricosus*. As indicating the excessive abundance of this mite in some parts of the country, Dr. Jay F. Schamberger, a leading dermatologist of Philadelphia, Pa., reported that—

In August, 1910, the National Guard of Pennsylvania was encamped at Gettysburg in a wheat field opposite the battle field of Gettysburg. The Third Regiment of Pennsylvania used straw in the soldiers' sleeping bags. About 300 men were attacked with grain itch. This information was received from Dr. Luburg, of Philadelphia, assistant surgeon of the regiment. The First Regiment, which was encamped close by, had straw supplied to it, but Dr. Turnbill, the surgeon, would not permit it to be used. Some few cases of grain itch developed among the men of this regiment. The straw was reported as received from a source in Gettysburg.

HESSIAN FLY INVESTIGATIONS.

Most of the investigation of the Hessian fly has been carried out in western Washington and Oregon, and comprises not only studies of parasites but efforts to spread the *Polygnotus* that has been so successfully introduced from Kansas. Besides this, considerable attention has been given to the effect of humidity on the hatching of the eggs of the fly, for the purpose of finding out whether wheat grown in arid regions by dry-land farming may not be safe from Hessian fly attack, because of the impossibility of the fly existing there.

In the East considerable damage has been done in some localities and an effort has been made to collect data relative to the time when seriously ravaged fields were sown. In all cases the sowings were found to have been made earlier than the experimental sowings carried on during past years by the bureau, indicated as safe.

THE NEW MEXICO RANGE CATERPILLAR.

Dry weather during the period of egg hatching last summer appeared to destroy the vitality of many eggs of the New Mexico range caterpillar. Beyond a surveillance of the country to determine the spread of the pest, little progress has been made in the work on this species.

THE ALFALFA WEEVIL

The situation regarding the alfalfa weevil is continually becoming more serious and alarming. The last Congress made immediately available \$10,000 for this investigation. With this fund work was begun April 1, 1911.

During the first half of the fiscal year an expert of the bureau, working in cooperation with the Utah Agricultural Experiment Station, traced the spread of the insect from Salt Lake southward to Springville and north to near Ogden, west to beyond Tooele, and east to near the borders of Wyoming and Colorado. Judging from what has been observed between Salt Lake City and Ogden and between Ogden and Brigham, the uniform normal spread of the pest is about 30 miles each year, though circumstances may greatly change this. During the last half of the fiscal year, with the aid of the new appropriation, a great number of experiments was carried out with mechanical contrivances for destroying the pest in infested alfalfa fields and thereby protecting the second and third crops. As elsewhere stated, through the aid of an agent in Italy four and probably five species of parasites have been transported from Italy to Utah and colonized in the fields. The results of this work can only be learned next spring, when the parasites should appear in the fields. Thus the work has divided itself into three sections—marking the spread of the pest, devising mechanical contrivances for its control in the field, and the introduction of parasites.

WHITE GRUB INVESTIGATIONS.

Investigations of the several species of *Lachnostenra* in different parts of the country were taken up, and considerable work has been done in New York, Pennsylvania, and Indiana. The present inten-

tion is to carry out a thorough and systematic investigation, over the entire area of distribution, of the economic relations of these insects to the production of grains and forage crops. This involves the greater portion of the time of several assistants.

WIREWORM INVESTIGATIONS.

An investigation of wireworms, which are very destructive insects, was begun two years ago in eastern Washington, and also to a limited extent in the Eastern States. Investigations of the species attacking wheat and corn in the extreme Northwest will probably be finished the present year and facts be in shape for publication. The beginnings that have been made in the investigation of these insects throughout the East and Middle West are being continued and extended.

CLOVER AND ALFALFA SEED CHALCIS.

So destructive has the clover and alfalfa seed chalcis become to alfalfa seed, especially in the Western States, that its destruction has become a serious obstacle to the production of alfalfa seed. A thorough investigation of the species has been taken up and considerable progress made in Arizona, Kansas, and Utah. It is also being investigated as a clover-seed insect throughout the East and Middle West.

THE CORN LEAF-APHIS.

The corn leaf-aphis (*Aphis maidis*) has received considerable attention in the North, not on account of its destructive habits—for it is a comparatively harmless insect there—but because of its supposed relation to the corn root-aphis. In the South, however, it is injurious to the barley crop, and the damage is very serious along the Mexican border from the Gulf to the Pacific and extending northward for a considerable distance. An effort is being put forth by the farmer to find some kind of grain that can be grown in that part of the country. So far it would seem that but for the attacks of this insect barley might be grown profitably and thereby solve this problem. In order to aid in the efforts of farmers over the area indicated, extended investigations of the species have been undertaken along the southern border of the country.

COWPEA AND SOY BEAN INSECTS.

The investigations of the cowpea curculio have been concluded and the results published in Bulletin 85, Part VIII, of this bureau. The area over which cowpeas and soy beans are at present being grown has become very extensive and is constantly increasing. An investigation of the insect enemies of these two forage crops has been undertaken by two assistants of the bureau and a portion of their investigations will probably be ready for publication during the coming fiscal year.

OTHER INVESTIGATIONS.

The investigation of the alfalfa butterfly in southern California has been carried to a point where practical information has been

secured, and as this seemed to be of considerable importance to the farmers, this information has been published in the form of a circular, while the investigations are being continued.

The investigation of the new gallfly attacking seed pods of alfalfa in Arizona and New Mexico is also being continued, as well as investigations of the southern corn leaf weevil.

The investigation of the relation of leafhoppers to the cultivation of grains and grasses has been included in a manuscript now ready for publication.

A number of destructive insects not heretofore known to the farmers of the United States has been found about Brownsville, Tex., and their habits are being investigated with a view of finding out to what extent they may become injurious in the South.

A new rootworm has proved destructive to corn, sorghum, and millet. It is being investigated in both Texas and Arizona.

Two species of thrips not only injure the foliage of alfalfa in the Western States, but there is good evidence that they are involved in the blighting of the blossom. These two species are being investigated in southern California and Arizona, the accumulated data being nearly ready for publication in the case of one species. A third species is being investigated in Oregon and Washington.

A species of *Eleodes* has been destructively abundant in Washington, the larvae working a great deal of injury in wheat fields. This problem is likely to be completed during the present calendar year.

The investigations of the maize billbug have been completed and the results published in Bulletin 95, Part II. A similar investigation of an allied species, *Sphenophorus callosus*, is under way and definite results will be published, together with practical measures for methods of preventing a repetition of the serious damages to corn that have occurred in the past.

Next to wireworms and white grubs, the most destructive insects in cornfields, particularly where corn follows grass crops, are the corn webworms, and investigations of these insects have been taken up in Ohio, New York, Pennsylvania, Delaware, and North Carolina. Probably a number of years will be required for the completion of these investigations.

Investigations of cutworms and experiments for their control in cornfields have also been undertaken in several States.

WORK ON INSECTS AFFECTING VEGETABLE CROPS.

The work on insects affecting vegetable crops, carried on as heretofore under the direction of Dr. F. H. Chittenden, has during the year comprised investigations at several field stations in different parts of the country, where habits and life histories of truck-crop insects have been studied and where experiments have been made with different remedies with very considerable success. New insecticidal compounds have been tested and satisfactory field demonstrations have been made against some of the most important truck-crop pests.

INVESTIGATIONS IN TIDEWATER VIRGINIA.

The work in tidewater Virginia, mentioned in the last report, was continued through the year. Several species of plant-lice were experimented with, especially the cabbage aphis, the pea aphis, and the spinach aphis, and it was found after experimentation with various substances that nicotine sulphate, 1 part to 900 of water, with the addition of a little whale-oil soap, brought about the most effective results. Whale-oil soap at the rate of 5 pounds to 50 gallons of water gave practically the same results, but was injurious to the plants.

In the course of experiments to stop the injury of grasshoppers to kale, it was found that an application of whale-oil soap, 4 pounds to 50 gallons of water, completely checked the invasion of this pest, making the plants so distasteful that the grasshoppers soon left the field.

An interesting experiment was made with the use of a plumber's gasoline torch against the harlequin cabbage bug, and it was found that upon horse-radish 95 per cent could be destroyed by the torch without injury to the plants.

A lengthy series of experiments was made against the Colorado potato beetle with arsenite of zinc and lead chromate in comparison with better-known poisons. The lead chromate had little effect, whereas the arsenite of zinc at the rate of $1\frac{1}{2}$ pounds to 50 gallons of water was fairly effective.

An interesting series of experiments against earthworms on lawns was carried on, and the best results seemed to follow the use of kerosene emulsion, together with a proprietary compound composed of a mixture of 24 per cent soda soap and 20.50 per cent of fatty matter, combined with some less active ingredient.

INVESTIGATIONS IN SOUTHERN TEXAS.

In Texas much work was done on the onion thrips, an insect which damaged 25 per cent of the onion crop of Texas during the season 1910-11. When spraying was begun sufficiently early—that is to say, before the plants had begun to curl and before the ends of the leaves had begun to die—good results were gained. The insecticides which have given the most favorable results are nicotine solutions combined with whale-oil soap, strong turpentine soap, lye-sulphur, and the lime-sulphur solutions. Kerosene emulsion was used to some extent, but, owing to the hardness of the water in southern Texas, it was very difficult to secure an emulsion that would remain stable long enough to be applied. More work must be done in order to devise some method of spraying that will lessen the number of applications and to perfect a machine which will cover more than one row at a time without injuring the onions.

The seed-corn maggot caused damage to onions and other truck, especially beans, in the lower Rio Grande Valley, and the injury was greatest where cottonseed meal or other decaying organic matter was used as a fertilizer. The damage was almost entirely to the first planting, and where this approximated 50 per cent the entire crop was plowed up and destroyed by fire. The soil was cultivated in some form daily for about a week, and then a second planting was made of the field. This second planting did not suffer.

A number of other insects was studied, especially the cabbage aphid, the cucumber beetles, the garden webworm, and the sugar-beet webworm, and all were controlled by appropriate sprays.

The blister beetles did considerable damage to eggplant, beets, and potatoes. One application of arsenate of lead, 3 pounds to 50 gallons of water, checked their ravages. In five days after spraying not a living beetle was to be found in the field.

INVESTIGATIONS IN CALIFORNIA.

The principal work in California was conducted on the beet root aphid, the bean thrips, the celery leaf-tyer, and the strawberry white fly. The full life history of the beet root-aphid was worked out.

The bean thrips was the subject of an especial investigation. Its life history and different food plants were studied, and it was found that it is subject in one locality to attack by a very minute parasite. This is the first record of a hymenopterous parasite attacking any species of thrips, and it may be that the discovery will be one of importance if the parasite can be reared in numbers and induced to attack other species of thrips, as the pear thrips or the orange thrips.

The strawberry white fly was discovered late in September, causing extensive damage to strawberries in the San Gabriel Valley. This is the first record of this insect in California, and it has evidently been introduced into the State on nursery stock; in fact, in a shipment of four crates by express from Tennessee that was examined, the plants were found to be infested with the larvae and pupae of this insect. Since that time it has been found over almost the entire State. It seems to breed continuously throughout the season in California, and for this reason it is likely to become a more serious pest in California than in the East. Experiments showed that where plants are fumigated with hydrocyanic-acid gas before they are set out they can be freed from the pest.

The most serious attacks upon the sugar beet in southern California were by cutworms. In this part of the State alone over 1,000 acres had to be replanted. It was shown that where the first planting had been destroyed the second planting could be protected by the use of dry poisoned bait at a cost of from 40 to 50 cents per acre. If the attack is noticed in time the beets can be protected from injury by cutworms by the use of some bait at a cost of not over \$1.50 per acre, while to replant represents an outlay of fully \$5 to the acre. Farther north another agent with headquarters at Sacramento began work in January, 1911, but his work so far has been only preliminary.

INVESTIGATIONS AT ROCKY FORD, COLO.

Beginning with March, 1911, an agent was placed again at Rocky Ford, Colo., and began work upon the beet webworm, the beet army worm, the so-called alkali bug, and the onion thrips. The extensive damage to sugar beets, cantaloupes, beans, and other crops during 1910 by grasshoppers also led to work upon these insects. Studies have been begun upon the flea-beetles damaging sugar beets and upon the sugar-beet leafhoppers.

WORK IN INDIANA.

Although the onion thrips has been the subject of investigation for the past four years in Florida, Colorado, California, and especially in southern Texas, an outbreak of this insect in the vicinity of Knox, Ind., covered an entirely new region where conditions are quite different. Damage from the thrips in that region during 1910 was estimated at \$54,000 and undoubtedly will prove much greater in 1911, as the acreage devoted to this crop has been doubled. Here the mistake has been that the growers do not begin work upon the thrips in time. Experiments are now going on and new adjustments are being made on sprayers which will undoubtedly give excellent results.

Cutworms damaged onions in this region during May and early June, and about 400 acres were treated with the usual bran-mash remedy with excellent results.

OTHER WORK.

Investigation of insects injurious to late cauliflower and related crops on Long Island has been begun.

Work upon asparagus insects has been taken up in Maryland, and the egg parasite of the asparagus beetle has been imported from Massachusetts.

Although the sprays tested have been found to be effective against plant-lice on the various truck crops in tidewater Virginia, it has been deemed worth while to import ladybird beetles in the effort to hold the plant-lice distinctly in check. The spotted ladybird has been introduced from New Jersey and liberated at Warrenton, Va., with promising results. In cooperation with the California State Horticultural Commission 60,000 beetles were sent from California for liberation near Norfolk. The species was the so-called convergent ladybird. The main object of this last introduction was to endeavor to keep the spinach aphis under control in this way, since the growth of the spinach plant is such that it is very difficult to reach the plant-lice with a spray.

Work on hop insects has been taken up in California, and the hop flea-beetle, the red spider of the hop, and the hop aphis have been studied. Excellent reports of progress in the control of these insects have been made.

WORK ON INSECTS AFFECTING CITRUS FRUITS.

The work on insects affecting citrus and other subtropical fruits is carried on under the direct supervision of the assistant entomologist, Mr. C. L. Marlatt. The principal subjects under investigation have been the white fly in Florida and the orange thrips in California, together with certain minor or newly introduced insect pests, chiefly in Florida. The hydrocyanic-acid gas fumigation investigation was completed July, 1910, and was discontinued during the last fiscal year.

WORK ON THE WHITE FLY IN FLORIDA.

It was indicated in the report of last year that the main features of the Florida white-fly investigation were approaching completion. The life-history studies, fumigation experiments, and control by

fungous disease have been carried out probably in sufficient fullness and detail, and the final reports covering these subjects are now in press or practically ready for publication. Aside from the completion and reporting on these subjects, the chief work of the year has been experimental testing and demonstration of the value of different spray applications. The conditions of Florida citrus culture are such that very often gas treatment is too expensive, especially with an insect such as the white fly, where reinfestation from neighboring neglected groves is very easy. Hence the necessity of determining the most practicable and effective spray applications, which are much cheaper, for a single treatment at least, than hydrocyanic-acid gas fumigation. The principal insecticide washes experimented with include (1) a considerable series of oil-soap emulsions made with different brands of oil; (2) several of the commercial miscible oils which are very similar in composition to the oil-soap emulsions; and (3) sulphur washes. A good many other recommended mixtures have also been tested, and the Florida grower has been protected in this way from the purchase of worthless insecticides. It was hoped that the insecticide work would be completed this season, but it has not been possible to bring it to a conclusion, and another season's work will be required to finish the needed experimental tests. This work has been conducted, in all cases where the mixture warranted it, on a considerable scale, often over entire orchards, to give the tests the greatest practical value. It seems pretty well demonstrated that spraying will, under Florida conditions, be more generally adopted in the future than control by fumigation.

In a previous paragraph in this report, under the heading "Importations of useful insects," an account has been given of the sending of an expert assistant in search of the original home and the natural enemies of the white fly. This forms an integral and important portion of the white-fly work.

THE ORANGE THIRIPS.

The investigation of the orange thrips is still under way at Lindsay, Cal., and has been extended to southern California, particularly in the Riverside district, where the same or an allied thrips is causing considerable damage. Control by cultivation and fumigation proved unsatisfactory. The spray which has given the best results is a lime-sulphur solution with a tobacco extract added. Three applications—two in the spring and one in the fall—have resulted in saving from 20 to 60 per cent of the fruit. The work of the past fiscal year has been a continuation of spraying tests modified from the results obtained the previous year in connection with demonstration orchard sprayings. More than 20 different spray tests are being carried out, including, in addition to the sulphur washes, various soapy, oily, and tobacco washes, a plat of 50 trees being used in each test, with suitable check trees left unsprayed. The season has not been altogether favorable for these experimental tests in that the thrips itself has been less abundant, owing to climatic variation, than in previous years, but it is expected that the work of the fiscal year 1912 will fairly well demonstrate the best means of control by spraying. An investigation has been made of the situation at Riverside, and some preliminary spraying experiments are under way.

MISCELLANEOUS SUBTROPICAL INSECTS.

As opportunity has offered, some investigation has been made and a careful watch has been kept of insect pests, particularly newly imported ones, affecting other subtropical fruits. This relates particularly to *Pulvinaria psidii*, probably the worst pest in southeastern Asia of citrus and other subtropical fruits. This insect has in recent years been introduced on nursery stock into Florida, and seems to have been widely distributed by one of the leading nursery firms of that State. It is now exhibiting its possibilities for damage, particularly on fig, at West Palm Beach, Miami, and other points in Florida. The *Aleyrodes howardi*, a not very close relative of the white fly, has become established on the east coast of Florida, having evidently been brought over on stock from Cuba, where it seems to be native. An oriental scale pest, *Conchaspis angraei*, has become established on figs at Miami and probably elsewhere in Florida. The mango weevil, *Cryptorhynchus mangiferae*, has come in very commonly in mango seeds imported for planting during the last year. A warning circular on this insect has been issued by this bureau. Two important mango scales which have been brought in on recent shipments of mango trees to this country are still in existence in Florida. These mango pests, and especially the weevil if it becomes established, will seriously affect the future of the mango industry of Florida.

INVESTIGATIONS OF INSECTS IN THEIR DIRECT RELATION TO THE HEALTH OF MAN AND DOMESTIC ANIMALS.

THE HOUSE FLY AND THE MALARIAL MOSQUITO.

The work upon the house fly has been continued and new facts have been ascertained which have a practical bearing upon the general crusade now being carried on in this country against this disease-bearing species. A new Farmers' Bulletin upon the subject has been published and is being widely distributed, and many communities in various parts of the country are making an organized effort to limit the numbers of the pest.

The spread of the boll weevil into the Delta region of Mississippi has complicated the labor problem in that part of the country, since the negro population is moving away into regions not yet reached by the weevil. The substitution of white labor for this vanishing negro labor meets with the strong obstacle that although very rich that portion of the country is highly malarious. A Farmers' Bulletin entitled "Some Facts about Malaria" has, therefore, been published during the year, and in it the full story of the relations between the *Anopheles* mosquitoes and malaria is told. A companion Farmers' Bulletin giving remedies to be used against mosquitoes was issued at the same time.

WORK ON TICKS.

Under Messrs. Hunter and Bishopp, of the bureau, work on the tick which has been proved to be the transmitter of the disease of man known as the Rocky Mountain spotted fever was given especial attention. The distribution of the species was studied throughout a portion of the year 1910 and it was found to occur in more than 180

formerly unsuspected localities. The area in which the disease carrier occurs was accurately mapped, as indicating the possible distribution of the disease. The investigation of this dangerous tick in the Bitter Root Valley, where a very virulent strain of the disease occurs, was continued along the lines mentioned in the last report. Cooperation with the Montana Experiment Station and the Bureau of Biological Survey was continued. Early in this investigation two discoveries of great importance were made. One was that the tick is remarkable in its ability to exist for a long period without feeding. The adult tick was found to be able to exist for nearly two years without a host. The other discovery is that the adult tick is practically restricted to domestic animals, while the immature stages live practically only upon certain small wild mammals which never carry the adults. The first of these discoveries made it evident that any plan of starvation, such as is practiced with the tick which transmits Texas fever of cattle, is entirely out of the question. The other discovery, however, at once indicated a feasible line of attack. Since in the vast majority of cases the adult never develops upon animals other than live stock, it is unnecessary to pay any attention to the immature stages found commonly upon small wild mammals. By destroying the full-fed females on domestic animals during the spring and early summer, eradication may be accomplished. There are several species of ticks which occur in the Bitter Root Valley, but the only one which need be considered is known as *Dermacentor venustus*. The others occur in so small numbers or are of such peculiar habits that they can not serve as transmitters of the disease in any important way. Since the one tick which shows practical restriction of the adult stage to domestic animals is the only transmitter of the disease which needs to be considered, the eradication of the tick by dipping methods will undoubtedly eliminate the disease from that region.

A general suggestion toward this method of control was made some years ago by the late Dr. H. T. Ricketts, but the work of the bureau has placed the plan upon a certain basis and has made possible certain detailed methods of procedure which will be considered fully in a bulletin shortly to be published. These plans relate especially to the Bitter Root Valley, where 15 or more deaths from spotted fever occur annually, but the same basis for control may be employed in Idaho and other States where the disease is found.

During the investigation an effort was made to educate the people in regard to the tick and the desirability of its control. The interest of the public was sufficiently aroused to cause the erection of a dipping vat at Florence, Mont., by popular subscription.

Work upon the cattle tick was continued throughout the year. In order to complete our knowledge of the effect of different climatic conditions on the tick, experiments to determine the length of the different developmental periods, and particularly the nonparasitic periods, were continued. This information is of importance in the work of eradication of this tick by the starvation or pasture rotation plan. In this work the cooperative arrangements with the Tennessee Experiment Station were continued. Experiments were conducted which throw much light on the relation between rations and tick attack. Additional experiments with feeding sulphur to cattle indi-

cate that the practice is useless and results only in the expenditure of considerable sums without returns.

In addition to the work upon these two disease-bearing species of ticks, the study of a number of other injurious forms was continued with especial reference to control. Among the more important ones are the fowl tick, which practically prevents successful chicken raising in certain sections of the Southwest, and the spinose ear tick, which is an important pest to live stock in western Texas, New Mexico, Arizona, and parts of California, Nevada, and Utah. The biology of about 19 species of ticks, most of which are of economic importance, has been worked out and the information put in form for publication.

SIMULIUM AND PELLAGRA.

On account of the claim made by Dr. Sambon in the early part of 1910 that a species of fly of the genus *Simulium* transmits the disease of human beings known as pellagra in Italy, collections of flies of this genus in various parts of the South were made. The work down to the present time seems to show that there is no connection whatever between the centers of pellagra infection and the localities in which species of *Simulium* are to be found in the greatest numbers.

WORK ON INSECTS INJURIOUS TO STORED PRODUCTS.

In the course of the work on insects injurious to stored products, which has been carried on, as previously, under the direction of Dr. F. H. Chittenden, especial attention has been given to fumigation and other remedies, including the effect of hydrocyanic-acid gas and bisulphid of carbon under different conditions, especially in hot and cold weather. In Texas and at Washington, D. C., in cold weather, it has been found that the gases are comparatively inoperative in low temperatures. Bisulphid of carbon used during a high temperature has been found unusually effective. The investigations have been conducted chiefly in Texas, Kansas, and Oklahoma, and considerable work of a preliminary nature has been done in the District of Columbia in special fumigators, and in cooperation with the Bureau of Plant Industry at Baltimore, Md. The results of remedial experiments with hydrocyanic-acid gas generated from sodium cyanid and with bisulphid of carbon, liberated in a high temperature, have been published. It has been shown that the lesser grain beetle possesses less resistant power to most gases than most of the other stored-product insects; that fumigations in low temperatures, especially below 50° F., are practically ineffective unless an excessively large amount of bisulphid of carbon or of cyanid gas be used, and that under these conditions it is very desirable that about 48 hours be the length of exposure in order to insure killing all insects, even in tight inclosures. It seems that under ordinary conditions and in a temperature of between 65° and 75° F. a general standard of 2 pounds to 1,000 cubic feet for 48 hours or more should be adopted for bisulphid of carbon treatments.

One of the most troublesome insects investigated during the year was the fig moth. Early in the fiscal year an agent was sent to Smyrna to investigate the conditions under which figs coming to the United States become wormy, and on his return experiments were

carried on in a high temperature similar to that of Smyrna in order to determine if the fig moth can be destroyed with a short exposure. The results of the experimental work seem to be that in the temperature which is apt to be encountered in a building especially constructed for fumigation 2 pounds of bisulphid of carbon should be able to penetrate in 24 hours all of the infested figs, provided they are not too closely packed, and kill all or practically all of the contained larvae. Approximately air-tight fumigators are a practical necessity for the success of any form of gassing or fumigating.

During the year evidence has been obtained of the establishment of a new and dangerous insect pest in California, the broad bean or horse bean weevil, and there is danger of its introduction into other parts of the United States, since it is able to subsist on peas and other leguminous seeds. The same insect has been brought to New York City and other eastern ports and the seed condemned and destroyed. If vigorous measures are not employed to prevent its introduction from California eastward, it may lead to very serious injury to broad beans. The points of infestation in California are limited, and the pest could be stamped out.

The subject of insect damage to peanuts has been taken up during the year, and it has been ascertained that there is a loss from insects to this crop of surely more than a million dollars a year. This investigation is now under way and a preliminary circular covering the subject has been published.

INSPECTION WORK.

The current inspection work of the bureau relates to fruit, seeds, and plants imported by the Department of Agriculture and commercial importations consigned to Washington, either direct or in bond.

Customs advices relating to 63 commercial importations have been received this year, and, so far as possible, these plants have been inspected. There is no law which authorizes such inspection for the District of Columbia, and inspection can only be carried out by the courtesy of the importers. This has sometimes been refused or is often grudgingly given, and at best is without any effort to facilitate or make possible thorough examination. The worst feature of such imported stock is the masses of cheap ornamentals which are brought in and sold by department stores or sold under the hammer by auctioneers. This condition applies to other large cities as well as Washington. During the past year importations of this kind were made by two local department stores and one auction firm. The auction firm in question was courteous enough to allow the department to destroy a lot of young spruce trees imported from Holland, which were badly infested with a European spruce insect, *Lachnus juniperi* Fab., which is not known to occur in the United States.

In the case of the importations of new stock, plants, or seeds by the Department of Agriculture all such material coming to Washington is thoroughly inspected by officers of this bureau, and if need be, is disinfected or destroyed. Furthermore, all the lots of material which the department prepares for distribution are again inspected, and, if necessary, fumigated, before being sent out. In this way 750 differ-

ent shipping orders have been inspected for the Bureau of Plant Industry, and many of these lots have been fumigated.

In the case of the importations by the Department of Agriculture, this thorough inspection and fumigation is believed to safeguard such material and to reduce to the minimum the likelihood of the introduction of new insect pests.

As illustrating what may be brought in by such material and which in the case of private importers must often escape detection, it may be noted that more than 20 different pests have been intercepted on the importations by this department, many of these new to this country and with very unpleasant possibilities. These include such things as weevils infesting seeds; grasshoppers with wild grasses; grain insects; the mango weevil; a moth reared from mango seeds; scale insects; aleyrodid species (insects related to the white fly); a peach-seed weevil from Siberia, *Anthophonus druparum*, already a very injurious pest in Europe, and one which if introduced into this country will probably be even more destructive than the plum curculio; a cecidomyiid (related to the Hessian fly) on lotus introduced as a fodder plant; several scale insects; eggs of a leafhopper in cuttings of persimmon and peach from China. The last, judging from its relationship to known pests, is capable of very great destruction to all sorts of orchard and ornamental trees. The eggs in this case are inserted under the bark, and to the ordinary observer would pass absolutely unnoticed.

The record of importations of new pests given above is the best possible argument for the passage of a national plant quarantine and inspection law.

THE NECESSITY FOR A NATIONAL QUARANTINE AND INSPECTION LAW.

In the last two annual reports the need of a Federal law which would give some reasonable control over the importation of plants and seeds has been urged, and the risk we are now running every year of bringing in new and dangerous insect pests or plant diseases with such importations has been pointed out. The efforts to obtain control legislation have not so far been successful, largely owing to opposition of the legislative committee of the National Nurserymen's Association, who were fearful that obstacles would be put on the import nursery business.

The bill which was drafted and submitted to the last Congress was a compromise with the nurserymen, in which the wishes of the latter were acceded to wherever possible. At their instance examination was provided for at the point of destination on the premises of the importer, instead of at port of entry, thus meeting the main objection which the nurserymen had had to the bill. A number of other changes were also made, at their instance; all the important ones, in fact, except the elimination of the power of establishing foreign quarantine against particular plants to keep out diseases or insect pests which could not otherwise be excluded. To state this provision indicates its absolute necessity. It is aimed particularly at such dangers as the potato-wart disease and the white-pine blister rust, which no inspection or disinfection would reach, and it would seldom apply to the regular import trade in seedling nursery stock.

As thus amended the bill was introduced during the concluding session of the last Congress and was favorably reported from the Agricultural Committee of the House, but, owing to the legislative conditions of that session of Congress, it was not possible to have it brought up in regular course and given adequate discussion. Near the close of the session it was brought up on the unanimous consent calendar, but no opportunity was possible in the few minutes allowed for debate to present the merits of the measure, and it failed to secure the necessary two-thirds vote to pass it under suspension of the rules.

A new measure has been drawn by the Solicitor of the Department of Agriculture, in conference with the different bureaus interested and with State officials representing various States most affected by the import nursery trade, and has been introduced in both the Senate and House of the present Congress (S. 2870 and H. R. 12311, 62d Congress, 1st session). The chief point of divergence from the bill of last year is that inspection of imported nursery stock is to be left to the different States instead of being undertaken by the Federal Government. A complete system of notification is arranged for, however, both by requiring a permit previous to importation and by subsequent advices to be given by the customs officer, the broker, or first receiver of the stock, and the common carrier transporting it. The features of the bill relating to foreign and home quarantine remain much as before.

The need for this legislation is just as urgent as ever. Fewer brown-tail moth nests were received on imported stock during the season just ended (1910-11), largely owing to the agitation in this country and the more strict supervision by foreign governments, and doubtless particularly to the natural fluctuation in the numbers of this pest abroad. These nests are, however, still coming in, some 100 nests having been reported as received in New York State and 2 in Ohio. Reports have not been received from other States. The danger from this condition is perhaps even greater than when the nests are coming in more abundantly. The infrequent finding of these nests will naturally lead to a laxity of examination and result in an even greater risk of the passing of infested material.

The department's connection with the work is the same as before. The voluntary reports received from the customs officers and the railroad companies have been transmitted to inspection officials of the several States. These reports are by no means complete, and can not be complete under existing conditions.

The inspection notices sent to this bureau by the customs officials at the various ports of entry for the last fiscal year (July 1, 1910, to June 30, 1911) indicate over 6,000 different shipments and some 90,000 separate parcels. This, however, includes bulbs, orchids, and greenhouse stock, as well as nursery stock proper. The total annual value of all plant importations in recent years has been a little over \$2,000,000, and the latest customs statistics available indicate that less than one-fourth of this relates to nursery stock, namely, trees, shrubs, and ornamentals, including seedlings. Roughly, therefore, one-fourth of the total number of shipments should be subject to careful examination. The standard trade in greenhouse materials and bulbs is subject to comparatively little risk of introducing new dangerous pests.

One of the worst features of the situation is the importation by department and 5-and-10-cent stores of foreign ornamental nursery stock, which very often is not reported, and which State inspectors have the greatest difficulty in tracing. Nursery stock from abroad is also sent to this country to be sold under the hammer at various auctioneer establishments in large cities, and in both of these cases it is almost impossible to trace such stock or make any adequate inspection of it. In this city, such stock has been examined by agents of this bureau under difficulty and without any real authority, and has in several instances been found infested with dangerous insects.

The record given elsewhere under the head of "Inspection work" of this bureau illustrates more pointedly the dangers which the introduction of foreign stock without proper supervision has for this country.

WORK IN BEE CULTURE.

The principal work in bee culture, carried on under the direction of Dr. E. F. Phillips, has been the study of bee diseases, both as to cause and remedy, and the further study of the extent to which these diseases are spread in the United States. The study of the causes of the two principal diseases has been continued in a satisfactory manner. *Bacillus larvæ*, the cause of American foul brood, has been further studied, and in case of the European foul brood the search for the cause has been continued faithfully and vigorously, but so far without entire success. While the cause for the disease has not been established, there is reason to suspect an organism which has so far failed to grow on any culture medium. Other organisms found in diseased material are being studied as an aid for laboratory diagnosis. The claims of other workers as to the cause of the disease known as European foul brood have not been substantiated. As an aid to other workers in the field, directions for the laboratory diagnosis of samples of suspected brood are being prepared.

A paper summarizing the more important publications on the etiology of bee diseases has been prepared and submitted for publication, and a Farmers' Bulletin on the symptoms and treatment of bee diseases has been published and is being widely distributed. This bulletin contains the available information which a bee keeper should have to control these diseases successfully. The treatment advocated by the bureau is proving very successful where properly applied.

But the greatest task has been, not to prepare the bulletins in question, but to ascertain more about the occurrence and the results of these diseases. No other line of investigation connected with bee-keeping compares with this one in practical importance. During the past fiscal year 1,054 samples of diseased brood have been examined as against 620 for the previous year and 280 for the year before that. A publication giving the distribution as known from samples examined up to March 1, 1911, has been issued, and since that time samples have been received showing the presence of American foul brood in 41 additional counties and European foul brood in 29 additional counties. The records on July 1 showed American foul brood in 335 counties in 39 States and European foul brood in 194 counties in 25 States. These figures do not, of course, indicate that every apiary in these counties contains the disease, but they show that the

diseases are far more widespread and destructive than was suspected in this country before the work was begun.

Particular attention has been paid to the occurrence of disease in Illinois, Iowa, Michigan, Ohio, and Pennsylvania, since there was especial need of information in these States. The devastation of apiaries which comes to light in this work is surprising. It is frequently difficult to get any information concerning a county other than that beekeeping has been practically wiped out. To obtain samples from the various regions containing disease entails an enormous amount of correspondence and the sending out of thousands of circulars, but the results seem to justify the effort. The sending out of letters and circulars of inquiry is in itself beneficial, since by this means bee keepers are induced to examine their colonies carefully and often find disease where it was not suspected. Their attention is also called to a danger which many do not know to exist and they are thereby put on their guard.

This work has also proved most valuable, since the data gained in this way assist apiary inspectors in their work, and also assist in enabling bee keepers to have inspection laws passed. If bee keepers can get reliable information concerning the character and treatment of brood diseases the loss is naturally greatly reduced.

A protozoan (*Nosema apis*), the reported cause of a supposedly infectious dysentery of bees, has been studied, and it is not considered that it is as yet definitely proved that this organism is the cause of the disease.

Work on the development of the bee has been continued, and studies of the egg have been practically completed.

Cooperation has been entered into with the State entomologist of Maryland in making a survey of beekeeping conditions in that State, and this work has been completed. Cooperative work of a similar character in Pennsylvania has been continued. The expert in charge of apiculture has assisted in the establishment of apiary inspection in Ontario by giving a short course of lectures to the bee inspectors at the Ontario Agricultural College at Guelph. This was considered important for the reason that we need protection against possible importation of diseases from Canada. He also assisted in establishing a course in apiculture at Syracuse University, and represented the bureau at the annual meeting of the National Bee Keepers' Association at Albany and at the meetings of the Michigan and Illinois Bee Keepers' Associations.

UNCLASSIFIED WORK.

As happens every year, a great deal of work has been done in different directions which can not be classified under the main sections. Investigations of pecan insects and of insects injurious to ornamental plants and shade trees have been continued. The bureau has been called upon to give advice in the matter of shade-tree insects from many cities in the country.

As mentioned in previous reports, the work of the specialists of the bureau in the determination of specimens sent in by State entomologists and other workers in practical entomology has been very large. This has occupied a great deal of time, but since it has a very important bearing upon the work of the State entomologists, teachers

of economic entomology, and others engaged in practical work, it not only can hardly be avoided, but it has ultimately a considerable value. During the fiscal year nearly 30,000 specimens were determined for these workers.

The correspondence of the bureau continues to increase, and in addition to correspondence by circulars more than 32,500 letters have been written during the fiscal year.

There has also been a large increase in the publications of the bureau, 75 separate numbers having been issued during the year.

PROPOSED WORK FOR THE FISCAL YEAR 1912.

The main lines of field work against the gipsy and brown-tail moths under way at the close of the fiscal year 1911 will be continued, and in conjunction with the Massachusetts State forester's office and the town authorities an attempt will be made to exterminate the gipsy moth in a belt 10 to 15 miles wide along the western infested border in Massachusetts, and a series of towns along the western and northern borders of the New Hampshire and Maine infestations will receive the same attention. At present there seems to be little hope of preventing the spread to the eastward in Maine. Scouting throughout the suspected territory in all of the New England States will be continued, and the inspection of forest products, and possibly of other suspected material shipped from the infested area, will be continued. In July, during the flight of the brown-tail moth, small forces of men were stationed at several points to examine boats and trains for adult brown-tail moths attracted to the lights of these conveyances, and which otherwise would be taken to points where the insects are not known to exist.

With regard to the importation of parasites of the gipsy moth and the brown-tail moth, the bulk of the importations will be still further reduced, and more careful studies will be made to determine the spread and multiplication of those species already established, and more diligent search will be made for those parasites introduced and liberated which have not yet been recovered. The admirable success of the agent who spent the last half of the previous fiscal year in Italy, which so far exceeded any previous efforts of the kind, indicates that it will probably be desirable to make the same intensive studies and the same careful effort to import parasites not yet established, from one or more favorable points.

With the boll weevil, the experiments to determine the feasibility of some plan for its control other than the burning of the plants in the fall will require a large amount of attention, and this investigation will be extended to include a number of suggestions that have come to light as the result of previous work. The poison experiments will be continued, as well as the work with the boll-weevil parasites. The results of the winter shipment of parasites from Texas to Louisiana will be carefully followed up. The exact status of the boll weevil throughout the infested area will be determined as usual and agents will trace the dispersion to determine the extent of the summer and autumn flights of the insect. Attention will be paid to the testing of new remedies and machines. More than a score of these means of control are now awaiting tests.

The work against tobacco insects will be continued and expanded, and experiments in the control of the sugar-cane borer will be conducted on a larger scale. The study of the rice weevil will be carried on further, and the work on the Argentine ant and the cotton red spider will also be continued along the same lines as during the previous year.

With forest insects, the demonstration work in the Northwest will be expanded, and a strong effort will be made to secure the cooperation of the timber owners in the South in order to carry on effective work against the southern pine beetle.

With deciduous fruit insects, several of the investigations recently begun and already indicated will be continued. Codling-moth studies are planned for the Southwest in addition to the work in the Allegheny Mountain region. The plum-curculio investigations will be practically concluded in the season of 1911. A specific study of the insect enemies of nuts on the tree will be begun in the South and will be later extended to the Pacific coast. Work on the woolly apple aphid and the apple-tree borers will be given considerable attention, and if practicable it is planned to begin a specific study of the insects damaging nurseries and of the efficiency of hydrocyanic-acid gas fumigation as practiced by nurserymen on deciduous fruit-tree nursery stock. The grape Phylloxera investigations will be continued, and more demonstration work will be given to the pear thrips in California.

With cereal and forage insects, the same problems will continue under investigation, and especial attention will be paid to the alfalfa weevil, which continues to spread and for which no satisfactory remedy has yet been found.

With insects affecting vegetable crops, the work of the past fiscal year will be carried on upon practically the same lines.

With insects affecting citrus crops, the fiscal year 1912 should complete the white fly investigation, except in so far as further efforts will be necessary to introduce and establish the parasitic and predaceous enemies of the white fly discovered in central India. The work with different oily, soapy, or other sprays, carried on experimentally and also on orchard or demonstration scale, should be completed during the coming winter. Some special investigations of newly discovered citrus and subtropical pests in Florida will be undertaken, and the investigation of the orange thrips will be continued.

Under the head of "Insects in their direct relation to the health of man and domestic animals," the work on the spotted-fever tick of the Northwest will be concluded in the autumn. The United States Public Health and Marine-Hospital Service has taken up this work at the request of the State Board of Health of Montana and the services of the bureau will be no longer needed. Work on the southern cattle tick and other southern ticks will be continued, however, and such experimental work as can be done with the house fly and mosquitoes will be carried on.

There will be no great innovations in the work on insects injurious to stored products, and the inspection work will be continued as thoroughly as possible in the absence of a national law.

In bee culture, the increase in the appropriation makes it possible to take up certain lines of work which have been much needed. The

investigation of bee diseases will again receive the principal attention of the service and will be enlarged along much the same lines as heretofore, with the addition of further experiments in the treatment of both infectious diseases. Several practical problems, such as the production of comb honey and the wintering of bees, will be begun in the hope of devising better methods as well as to make known generally the best methods now employed. The study of the sense organs of bees will be begun, and a study of wax secretion will be conducted to learn the conditions under which wax is most rapidly secreted and the activities of the bees during comb building.

**PLANS FOR WORK RECOMMENDED FOR THE YEAR ENDING JUNE
30, 1913.**

It was my intention to recommend a considerable increase in the estimates for this bureau for the fiscal year 1913, but I am understand that it is your desire and the desire of the chairman of the Committee on Agriculture of the House of Representatives that no increases shall be submitted, and I therefore recommend that the estimates for this bureau be the same as those for the fiscal year 1912.



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